Center Independent Research & Development: GSFC IRAD

Simultaneous Localization and Mapping for Satellite Rendezvous and Proximity Operations

Completed Technology Project (2017 - 2018)

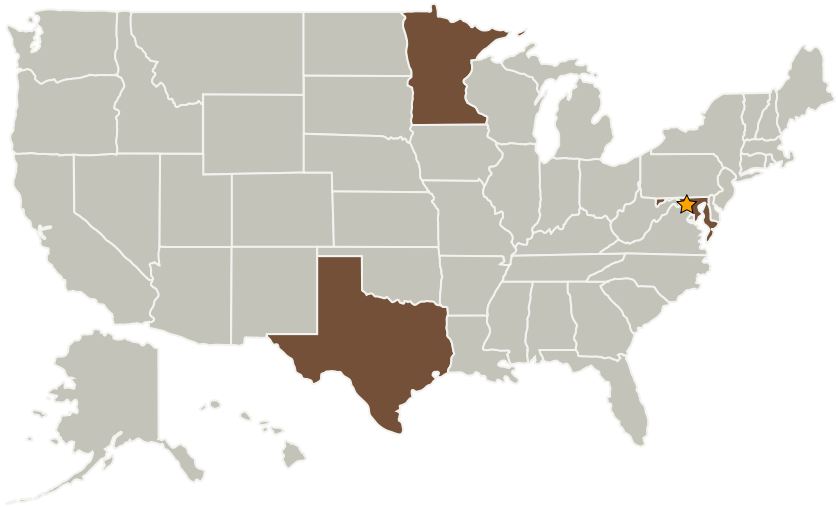
Project Introduction

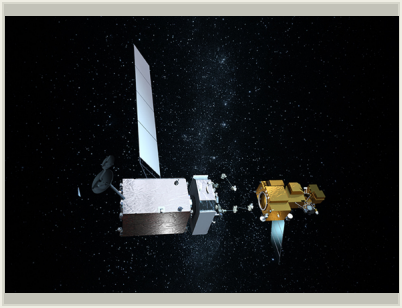
Simultaneous Localization and Mapping (SLAM) attempts to estimate a vehicle's position and orientation (localization) and the location of an initially unknown number of features in the environment (mapping) simultaneously. The satellite relative navigation and pose estimation problem can be considered a 3D SLAM problem where we are estimating the position, velocity, attitude, and attitude rate of the primary satellite relative to the target satellite while simultaneously estimating a map of the target features. The goal of this project is to demonstrate the feasibility and effectiveness of using SLAM for autonomous, precise relative navigation and pose estimation without reliance on GNSS for RPO applications such as satellite proximity operations for inspection, satellite rendezvous for servicing, and near asteroid/comet navigation.

Anticipated Benefits

Autonomous relative navigation and pose estimation enables a number of missions of interest to NASA including satellite inspection and servicing, rendezvous and docking, and small body (asteroid and comet) exploration. Due to its enhanced ability to estimate in the presence of noisy measurements and clutter, SLAM has the potential to significantly improve our ability to perform relative navigation and pose estimation with an asteroid or satellite that is not well known beforehand, operate in a wider range of lighting conditions or in a lower signal-to-noise environment.

Primary U.S. Work Locations and Key Partners





Satellite Servicing Application of Simultaneous Localization and Mapping

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Simultaneous Localization and Mapping for Satellite Rendezvous and Proximity Operations

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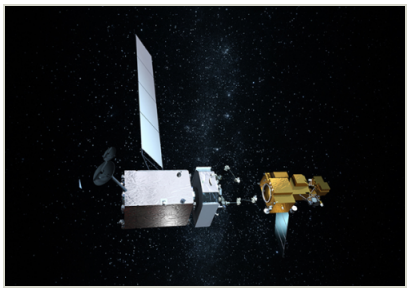
Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
The University of Texas at Austin	Supporting Organization	Academia	Austin, Texas
Universidad de Chile	Supporting Organization	Academia	Santiago, Chile
University of Minnesota-Twin Cities	Supporting Organization	Academia	Minneapolis, Minnesota

Primary U.S. Work Locations	
Maryland	Minnesota
Texas	

Images



Restore-L Satellite Servicing Mission
Satellite Servicing Application of Simultaneous Localization and Mapping
(https://techport.nasa.gov/image/28198)

Organizational Responsibility

Responsible Mission Directorate:
Mission Support Directorate (MSD)

Lead Center / Facility:
Goddard Space Flight Center (GSFC)

Responsible Program:
Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:
Peter M Hughes

Project Managers:
Jason W Mitchell
Timothy D Beach

Principal Investigator:
David E Gaylor

Co-Investigators:
Cinnamon A Wright
Joseph M Galante
Martin Adams
Ryan Russell
Brandon A Jones
Richard Linares

Simultaneous Localization and Mapping for Satellite Rendezvous and Proximity Operations

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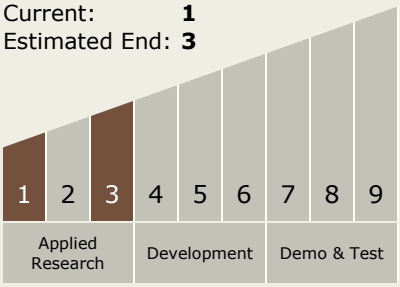
Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.2 Navigation Technologies
    - TX17.2.1 Onboard Navigation Algorithms

Target Destinations

Earth, Others Inside the Solar System, Foundational Knowledge